From the Society for Clinical Vascular Surgery

Endoluminal embolization and revascularization for complicated mesenteric pseudoaneurysms: A report of two cases and a literature review

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Mesenteric artery pseudoaneurysms are a rare and complex complication after abdominal trauma, surgery, or inflammatory disease. These lesions can be associated with compression or erosion into adjacent structures and may result in life-threatening hemorrhage. Traditional management has been open surgical ligation, aneurysm resection with interposition grafts, or resection or partial resection of the end organ involved. We present two cases of endovascular repair of complex mesenteric pseudoaneurysms. One patient presented with a recurrent pseudoaneurysm of the superior mesenteric artery and the second presented as recurrent gastrointestinal bleeding secondary to a traumatic celiac artery pseudoaneurysm-to-pancreatic duct fistula. A systematic review of the literature on endovascular management of mesenteric vascular disease and mesenteric pseudoaneurysms is included in this report to allow these cases to be put into proper perspective. (J Vasc Surg 2007;45:381-6.)

Mesenteric artery pseudoaneurysm is a rare but complex complication after abdominal trauma, mesenteric revascularization, or inflammatory disease. These lesions can result in compression or erosion of adjacent structures or life-threatening hemorrhage. Traditional management has been operative repair with an interposition graft or arterial ligation and, if needed, resection or partial resection of the end organ involved.[1] Advances in technology have led to endovascular approaches to these lesions. Reports have emerged describing thrombin injection, embolization, or stent graft exclusion, or a combination, in both individual cases and small retrospective series. We present two patients with mesenteric artery pseudoaneurysm and their subsequent endovascular management as well as a review of the English literature illustrating an evolution of the management of mesenteric pseudoaneurysm.

CASE REPORTS

Patient 1. A 79-year-old woman presented with acute worsening of chronic abdominal pain and a large, tender, pulsatile mass in her upper abdomen. Her medical history included aortoiliac disease, chronic mesenteric ischemia, and renal artery stenosis. Prior vascular reconstructions included aortobifemoral and superior mesenteric artery (SMA) bypasses and left renal angioplasty and stenting.

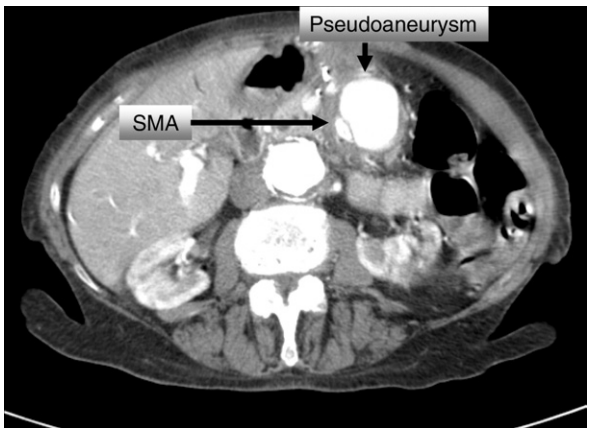

Fig 1. The initial abdominal computed tomography scan shows a pseudoaneurysm *(arrow)* of the superior mesenteric artery *(SMA)* that recurred in a 79-year-old woman 7 months after a previous open SMA pseudoaneurysm repair.

Seven months before admission, the patient underwent operative repair of a symptomatic SMA pseudoaneurysm with a polytetrafluoroethylene (PTFE) interposition graft. Her recovery and subsequent 7 months were uneventful until 3 days before admission, when she developed rapidly progressive abdominal discomfort, food intolerance, tachycardia, and a fall in her hematocrit.

From the Jobst Vascular Center.
Competition of interest: none.
Presented at the 2006 Annual Symposium of the Society for Clinical Vascular Surgery, Las Vegas, Nev, March 8-11, 2006.
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0741-5214/$32.00

doi:10.1016/j.jvs.2006.09.010

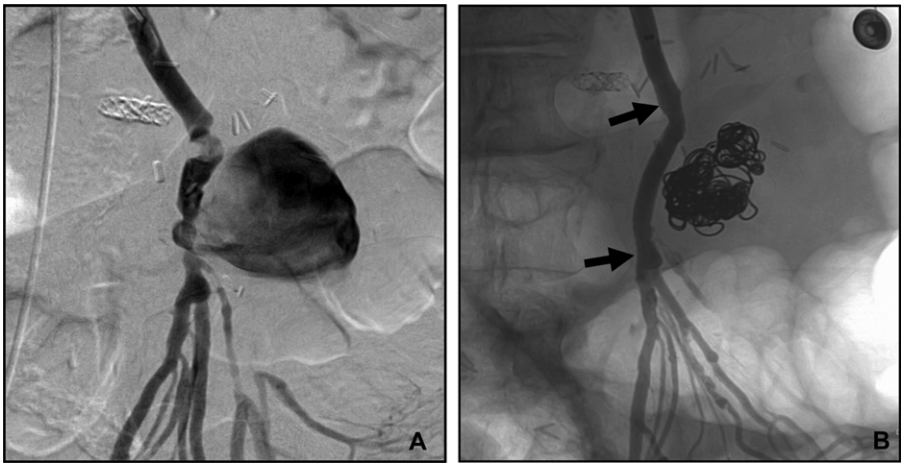

Fig 2. A, A preintervention arteriogram of the superior mesenteric artery (SMA) shows the pseudoaneurysm. **B,** A postintervention arteriogram demonstrates successful exclusion of pseudoaneurysm by stent grafts.

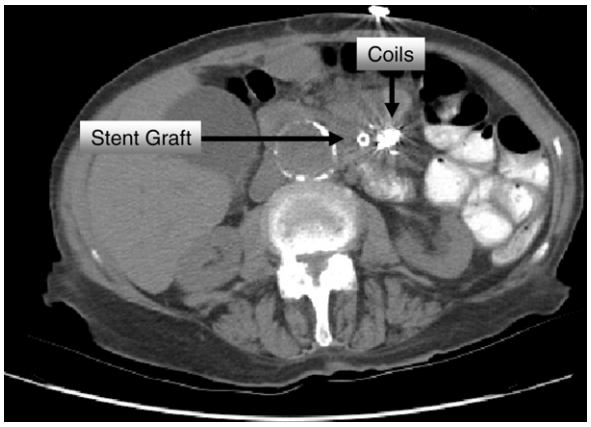

Fig 3. An abdominal computed tomography scan at 1 month after the interventions shows a patent superior mesenteric artery and excluded pseudoaneurysm *(arrows)*.

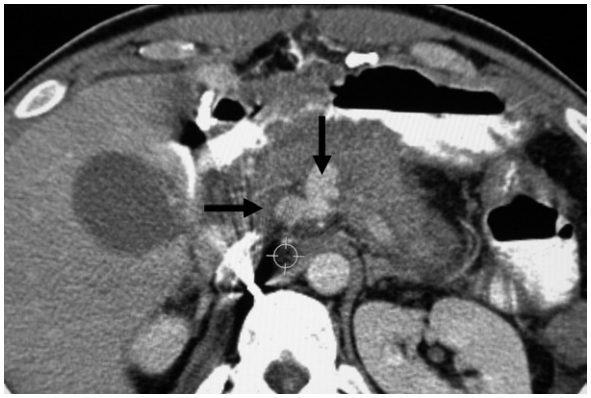

Fig 4. An abdominal computed tomography scan with contrast shows a pseudoaneurysm of the celiac artery *(arrows)* in a 32-year-old man who sustained a gunshot wound of the abdomen 6 months earlier. The patient presented with recurrent gastrointestinal bleeding.

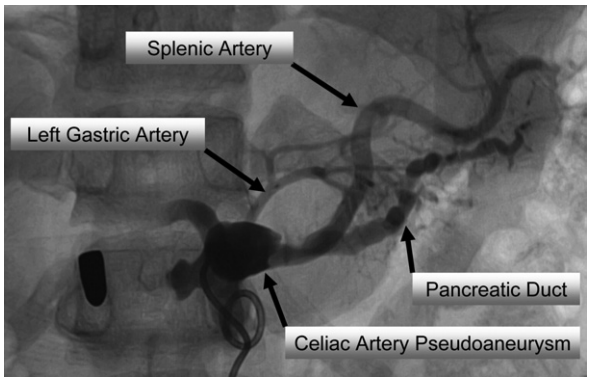

Fig 5. Selective arteriogram of the celiac artery reveals a pseudoaneurysm and arteriopancreatic duct fistula (arrows).

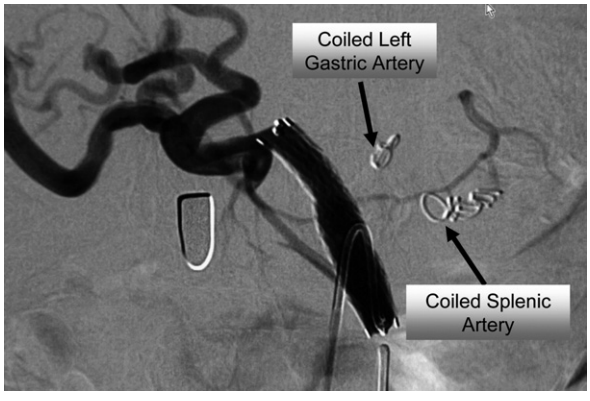

Fig 6. A selective arteriogram of the celiac artery after coil embolization of the left gastric artery and splenic artery and covered stent graft of celiac trunk to common hepatic artery shows that the arteriopancreatic duct fistula has been obliterated.

Table I. Literature review: embolization experience

Year published	*Author*	*Embol (n)*	*Tech success % (n)*	*Conv*	*Comp % (n)*	*Mort % (n)*	*F/U (months)*
1987	Mandel[4]	19	79 (15)	N/A	N/A	0	N/A
1987	Baker[5]	8	100 (8)	3	13 (1)	0	N/A
1992	Salam[6]	16	81 (13)	0	8 (1)	0	8m
1993	Repasky[7]	1	100 (1)	0	0	0	N/A
1996	Stambo[8]	8	88 (7)	1	0	0	21
1998	Reber[9]	5	100 (5)	0	40 (2)	0	35
1999	Hama[10]	1	100 (1)	0	0	0	10
1999	de Perrot[11]	3	100 (3)	0	0	33 (1)	N/A
2000	Carr[12]	6	67 (4)	2	50 (3)	11 (1)	N/A
2000	Carrmeci[13]	9	56 (5)	4	0	0	N/A
2001	Hossain[14]	8	100 (8)	0	0	0	N/A
2001	Carr S[3]	4	100 (4)	0	25 (1)	0	N/A
2001	Kasirajan[15]	12	75 (9)	0	0	0	46
2002	Gabelmann[16]	25	92 (23)	1	50 (12)	4 (1)	49
2002	Pilleul[17]	18	78 (14)	N/A	N/A	N/A	0.4
2002	Parildar[18]	22	95 (21)	1	0	5 (1)	12
2003	Flati[19]	1	100 (1)	0	0	0	11
2003	Tessier[20]	2	100 (2)	0	0	0	N/A
2004	Deshmukh[21]	30	97 (29)	0	7 (2)	3 (1)	N/A
2004	Sessa[22]	13	100 (13)	0	15 (2)	0	N/A
2005	Lau[23]	14	100 (14)	0	50 (7)	14 (2)	N/A
2005	Saltzberg[24]	15	94 (14)	1	22 (3)	0	N/A
Total	—	240	89 (214)	6 (13)	17 (34)	3 (7)	22

Embol, embolization; *Conv,* conversion; *Comp,* complication; *Mort,* mortality; *F/U,* follow-up.

Table II. Literature review: stent graft experience

Year	*Author*	*Stents (N)*	*Complications (%)*	*Death (%)*	*Type*	*F/U (mos)*	*Clinical patency*
1998	McGraw[25]	1	0	0	Self-made	12	Y
2000	Nyman[26]	1	0	0	Wallgraft	12	NA
2000	Paci[27]	1	0	0	Unknown	3	Y
2001	Tan[28]	1	0	0	Jostent	9	Y
2001	Yoon[29]	1	0	0	Jostent × 1	3	Y
2002	Venturini[30]	1	0	0	Jostent	12	Y
2002	Roček[31]	1	0	0	Jostent	30	NA
2002	Cowan[32]	1	0	0	Jostent	60	NA
2002	Larson[33]	2	0	0	Symbiot	13	NA
2002	Arepally[34]	1	0	0	Jostent × 3	4	Y
2002	Brountzos[35]	1	100	0	Hemobahn Wallstent	1	Y
2003	Appel[36]	1	0	0	Jostent & Wallgraft	6	NA
2003	Takahashi[37]	1	0	0	Gianturco Z	10	Y
2004	Ogino[38]	1	0	0	Passager stent	24	Y
2004	Seriki[39]	1	0	0	Jostent	NA	NA
2004	Gandini[40]	1	0	0	Jostent	7	Y
2005	Qu[41]	1	0	0	Talent	60	Y
2005	Saltzberg[24]	3	0	0	Viabahn	NA	NA
Total		21	1 (5)	0	—	17 (avg)	—

Comp, Complications; *F/U,* follow-up.

An initial abdominal computed tomography (CT) scan revealed a recurrent SMA pseudoaneurysm (Fig 1). The patient was not septic and did not have radiologic or clinical evidence to suggest infection as a cause for the recurrent pseudoaneurysm. We therefore believed arterial wall degeneration at the site of distal anastomosis was the likely cause.

An arteriogram demonstrated the SMA bypass graft and a pseudoaneurysm at the distal anastomosis (Fig 2, *A*). The SMA was cannulated, and multiple attempts to pass a 6-mm Viabahn stent graft (W. L. Gore & Associates, Flagstaff, Ariz) into the SMA were unsuccessful owing to stent inflexibility and the femoral approach. The left brachial artery was then cannulated; however, the stent graft could not be properly positioned owing to the SMA stenosis and inadequate catheter length.

It was thought that obliteration of the pseudoaneurysm cavity would temporize the patient's condition until a more appropriately sized and flexible stent graft could be obtained. Access into the pseudoaneurysm cavity was obtained with a microcatheter system. The pseudoaneurysm was then obliterated with coil embolization and thrombin injection. A completion arteriogram showed minimal contrast in the inferior portion of the pseudoaneurysm (Fig 2, *B*).

The patient was transferred to the surgical intensive care unit for monitoring, with plans to obtain approval and consent for the off-label use of a Jomed stent graft (Jomed International AB, Helsingborg, Sweden). Interestingly, the patient's symptoms had resolved and her aneurysm was no longer pulsatile or tender.

Two days later two 5-mm × 26-mm Jomed stent grafts were successfully deployed, excluding the pseudoaneurysm (Fig 2, *C*). The patient subsequently developed a symptomatic right common femoral artery pseudoaneurysm that required operative repair, and she also underwent thrombectomy and repair of a thrombosed left brachial artery.

She was discharged on oral antibiotic therapy 7 days after the stent graft procedure, tolerating a regular diet and without abdominal pain. A follow-up CT scan 1 month later showed a patent graft and no pseudoaneurysm (Fig 3). The patient remained asymptomatic for 7 months after the procedure, at which time she died of myocardial infarction.

Patient 2. A 32-year-old man presented with recurrent gastrointestinal (GI) bleeding 7 months after a gunshot wound to his abdomen. During the exploratory laparotomy at the time of his injury, a retroperitoneal hematoma in the area of the pancreas was observed and sutures were placed to control bleeding. His recovery was complicated by a pancreatic leak that was successfully treated with bowel rest and hyperalimentation.

During the next 6 months, he was hospitalized on four occasions for GI bleeding requiring blood transfusions. Results of esophagogastroduodenoscopy, colonoscopy, and small bowel follow-through were negative on each hospitalization. On his fifth hospitalization for the same problem, he underwent a bleeding scan, which was negative. A CT scan of the abdomen and pelvis demonstrated what appeared to be a pseudoaneurysm of the celiac artery (Fig 4), which was confirmed arteriographically.

The patient had no symptoms or signs of sepsis and no radiologic findings suggesting an infected pseudoaneurysm. The pseudoaneurysm had a wide neck and appeared to arise from the anterior portion of the celiac artery at its junction with the common hepatic artery, measuring 11 × 13 mm. Injection of the celiac artery demonstrated the source of the GI bleeding was a communication of the pseudoaneurysm with the pancreatic duct resulting in hemosuccus pancreaticus (Fig 5).

Operative repair was expected to be associated with significant morbidity, so an endovascular approach was planned. The goal was to exclude the pseudoaneurysm while maintaining hepatic perfusion. Using a bilateral common femoral artery approach, the celiac artery and SMA were cannulated. The celiac catheter was then advanced into the proximal splenic artery and left gastric artery and embolized with 5-mm and 2-mm coils, respectively, to prevent backflow into the pseudoaneurysm. The common hepatic artery was then cannulated and an 8-mm × 40-mm Fluency stent (Bard Peripheral Vascular, Tempe, Ariz) was placed in the hepatic artery just proximal to the gastroduodenal artery and extended into the celiac trunk. A completion arteriogram showed exclusion of the pseudoaneurysm and obliteration of the arteriopancreatic fistula (Fig 6).

The patient did well and was discharged 3 days later tolerating a full diet. During the next year of follow-up, the patient had no further GI bleeding. A mesenteric arterial duplex ultrasound examination 18 months after the procedure demonstrated a patent celiac stent and hepatic artery.

DISCUSSION

Opinions differ about management of aneurysms and pseudoaneurysms of the visceral arteries. Interestingly, some authors do not differentiate between true and false aneurysms. Traditionally, mesenteric artery aneurysms and pseudoaneurysms have been managed with open surgical repair. Repair of asymptomatic true aneurysms and pseudoaneurysms has been advised because of the high likelihood of rupture and resultant death. In one of the larger reports, 22% of patients with visceral artery aneurysms presented as emergencies resulting in 9% mortality.[2] A recent report indicates a more pessimistic presentation and outcome, with 42% of visceral artery aneurysm patients presenting with rupture resulting in 25% mortality.[3]

During the last two decades, there has been a shift in the management of these lesions. In the mid-1980s, case reports and small series reported successful treatment of mesenteric artery aneurysms and pseudoaneurysms with embolization. Technical success was 56% to 100%, with complication rates of 0% to 50% (Table I).[3-24] In fact, embolization alone was used to treat two-thirds of the aneurysms and pseudoaneurysms found in our literature review. Unfortunately, follow-up was poor and recanalization and patency rates were sporadically recorded.

In the late 1990s, reports of exclusion with stent grafts began to appear (Table II).[24-41] All reported cases were technical successes with no deaths and only one complication. A variety of stent grafts have been used; however, most were Jomed stent grafts, as used in our first patient. Follow-up was short-term and inconsistent.

Recently, reports of mesenteric pseudoaneurysms and true aneurysms are focusing on endovascular management. For pseudoaneurysms, the approach using embolization and thrombin injection to obliterate the pseudoaneurysm, followed by endoluminal stent grafting for optimal revascularization, is developing a therapeutic foothold (Table III).[3,13-15,21-24] The mortality rate of endovascular treatment is less than either open repair or medical management. The success of the endovascular approach has led some to endorse it as an alternative therapy for true mesenteric artery aneurysms, even in the presence of rupture.[3,13-15,21-24] We recognize that successful reports represent a bias in that technical failures and complications are rarely published.

Principles for endovascular management have been refined during the last two decades, contributing to the safe management of these patients. Sound management principles include the obliteration and exclusion of the aneurysm or pseudoaneurysm with maintenance of distal perfusion and obliteration of side branches. Magnetic resonance imaging or CT establishes the diagnosis and a management strategy can be planned. Selective arteriography reveals the details necessary for precise management. Identifying collateral and major branches, sizing vessels, and maintaining guidewire access are important principles.

Table III. Literature review: contemporary management of visceral artery aneurysms

Year	*Author*	*Study dates*	*N*	*VAA (n)*	*Open % (n)*	*Comp % (n)*	*Mort % (n)*
2000	Carmecci[13]	1980-1998	31	34	74 (25)	0	3 (1)
2001	Kasirajan[15]	1988-1998	9	12	22 (2)	0	0
2001	Carr S[3]	1990-2000	26	34	50 (15)	38 (5)	13 (2)
2001	Hossain[14]	1983-1998	30	30	63 (19)	21 (4)	11 (2)
2003	Tessier[21]	1980-1998	10	10	70 (7)	NR	0
2004	Sessa[22]	1975-2002	34	42	69 (29)	28 (8)	10 (3)
2005	Saltzberg[24]	1990-2003	65	65	14 (9)	11%	11
Total			205	227	51 (106)	17 (18)	8 (9)

VAA, Visceral artery aneurysms; *Open,* open repair; *Comp,* complications; *Mort,* mortality; *Endo,* endovascular; *F/U,* follow up.
*Medical treatment (nonoperative/no endovascular procedure).

Table III. Continued

Endo % (n)	*Comp % (n)*	*Mort %*	*Med* (n)*	*Comp %*	*Mort (N)*	*F/U (mos)*
26 (9)	0	0	—	—	—	NA
61	0	0	11% (1)	0	0	46
15 (4)	0	25% (1)	27% (7)	0	14% (1)	15
27 (8)	25 (2)	0	10% (3)	0	0	NA
20 (2)	NA	0	NR	NR	NA	46
31 (13)	23 (5)	0	NA	NA	NA	NA
28 (18)	20 (4)	0	58% (35)	0	0	21
29 (60)	15 (9)	0.2% (1)	22% (46)	0	2% (1)	32

Early in the evolution of endovascular procedures, embolization alone gained therapeutic favor. This is accomplished with coils, gel foam, thrombin, or a combination of these. The drawback of embolization alone is potential recanalization and recurrence of the pseudoaneurysm. The gastroduodenal artery has been reported to be the most common focal source of visceral artery aneurysm rupture and is usually amenable to arterial embolization. The most effective technique of arterial embolization is occlusion of the artery distal and proximal to the aneurysm.[3]

When occlusion of the vessel is not possible, direct embolization of the pseudoaneurysm, as was done in our first case, is recommended, assuming the pseudoaneurysm does not have a short, wide neck, which increases the risk of inadvertent vessel thrombosis or embolization. In these situations, stent grafts appear to be the preferred endovascular approach, thereby excluding the pseudoaneurysm and preserving distal perfusion. Unfortunately, the options for stent grafts are limited and the smaller diameter of these vessels is problematic. Drawbacks associated with stent grafts are the diameter of the target vessel, the difficult trackability, and the need for large access sheaths. Although covered stent grafts are available for cardiac angioplasty rescue, these are often not readily available in peripheral endovascular units.

Long-term follow-up of endovascular interventions for mesenteric artery aneurysms and pseudoaneurysms is not available. A prudent course of follow-up should include clinical evaluation combined with some form of imaging modality, including ultrasonography, CT, magnetic resonance angiography, and duplex subtraction angiography. It seems reasonable that timing of follow-up imaging be similar to that used for aortic endograft repair, generally at 1 month, 6 months, and annually thereafter, assuming normal findings.

CONCLUSION

We report two cases of endovascular management of complicated mesenteric pseudoaneurysms, with one presenting as recurrent gastrointestinal hemorrhage from a celiac artery to pancreatic duct fistula. The good early results of these complicated patients, avoiding serious morbidity, supports an initial endovascular approach for these patients. Combining embolization, where appropriate, with stent graft revascularization will likely maximize success. Long-term follow-up is important to assess the proper role of endovascular management in these patients.

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Submitted May 9, 2006; accepted Sep 4, 2006.